Site Need Statement

General Reference Information	
1 *	***Need Title*:** Chemical and Physical Behavior of Saltcake Wastes
2 *	***Need Code*:** RL-WT091
3 *	***Need Summary*:** Provide additional equilibrium and kinetic solubility data to guide the retrieval, delivery, and treatment of Hanford tank saltcake wastes.
4 *	***Origination Date*:** November 2000
5 *	***Need Type*:** Technology Need
6	***Operation Office*:** Office of River Protection (ORP)
7	***Geographic Site Name*:** Hanford Site
8 *	***Project*:** Retrieval ***PBS No.:*** RL-TW04
9 *	***National Priority:*** __X__ 1. High - Critical to the success of the EM program, and a solution is required to achieve the current planned cost and schedule. ____ 2. Medium - Provides substantial benefit to EM program projects (e.g., moderate to high life-cycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays). ____ 3. Low - Provides opportunities for significant, but lower cost savings or risk reduction, may reduce the uncertainty in EM program project success.
10	***Operations Office Priority*:** High
Problem Description Information	
11	***Operations Office Program Description*:** The overall purpose of the Retrieve and Transfer DST Waste function is to provide feed to the Waste Treatment Plant (WTP) and receive waste from SSTs. A primary objective of this function is to provide the tank farm infrastructure necessary to deliver waste to the WTP within established specifications. The baseline end state of the Retrieve and Transfer DST Waste function is: • Retrieval of all wastes from the DSTs • The safe, environmentally compliant transfer of this waste to the WTP • DSTs in a ready state for implementing closure and final disposal of the DST farms. The overall purpose of the Retrieve and Transfer SST Waste function is to move the waste from the SSTs into preferred storage in the DST system. A primary objective of this function is to develop and test alternative and improved retrieval technologies to past-practice sluicing. As part of this effort Leak Detection Monitoring and Mitigation (LDMM) approaches are being developed for concurrent deployment. To support this effort Cold Test Training & Mock-up Facilities are being established. The baseline end state of the Retrieve and Transfer SST Waste function is: • Retrieval of all wastes from the SSTs • The safe, environmentally compliant transfer of this waste to the DSTs SSTs in a ready state for implementing closure and final disposal of the SST farms.
12	***Need/Problem Description*:** Wastes must be transported and treated with minimum cost and delay. To this end, the transfer and treatment equipment must be designed correctly, and the operating plans must be accurate. Successful planning, equipment design, and plant operation all rely on accurate knowledge of the chemistry and physical properties of the wastes to be treated. In particular, detailed knowledge of waste component solubilities permits planning to take place to ensure that production expectations are achieved. Although a good deal of information has been obtained about the elemental composition of the waste, we do not yet have complete knowledge of the chemical compounds and mineralogy formed by these elements. Accurate knowledge of the chemical compounds present in saltcake wastes is important to predict how much of the waste will dissolve as a function of the amount of dilution water added, temperature, and other

	process parameters. The chemical equilibrium software package Environmental Simulation Program (ESP; OLI Systems, Inc., Morris Plains, NJ) is used on the Hanford Site to calculate the amounts of each waste component in the solid and liquid phases of partially dissolved saltcakes. However, these calculations are very challenging for the software because of the many species present in the waste; the high ionic strengths of typical Hanford wastes also strain the reliability of these calculations. Therefore, equilibria must be measured with actual wastes under expected process conditions to verify ESP calculations and to correct any deviations that are discovered. A systematic study should be made to identify ESP shortcomings, determine the data required to correct them, determine whether the data already exists (in the open literature or in DOE-sponsored reports), and organize and perform an efficient laboratory test program to obtain missing data. Saltcake transfers are expected to occur at a nominal sodium concentration of 5M, so the possibility of a pipe plugging during a saltcake waste transfer is very low. However, unusual processing scenarios, such as a pump failure during cold weather may lead to situations where solid phase formation could occur. ESP should be able to predict solid formation (insofar as the process conditions, such as pipe temperature, can be predicted). However, ESP will not (directly) predict the physical form of the solids, which may range from gel or sludge to large, pipe-filling crystals, depending on the chemical composition, cool-down rate, and other such factors. Information about the physical form of solids that may be expected is needed to plan for recovering from such process upsets. This information will also be useful in other tank farm programs, such as Interim Stabilization (saltwell pumping). Studies to date show that there can be sizable portions of nominally soluble species such as sodium ion or cesium ion that remains in solids after extensive water contact. The form that these soluble species exist in should be explored and suggested methods to retrieve these should be tried. The waste contains sparingly soluble salts such as sodium oxalate, sodium sulfate, and certain double salts such as sodium fluoride phosphate. These sparingly soluble salts may limit the effectiveness of simple water additions to dissolve the salt cake. An understanding of the effect of ionic strength and common ion effects need to be developed. There is also a concern with these sparingly soluble salts that they may be dissolved at one location in the salt bed and then reprecipitated in another portion in the salt bed . Another issue is post transfer precipitation in the receiving tank. **Problem Background:** Solids and gels may form in the Hanford tank waste under certain processing conditions. Transfer lines have been plugged when solids or gels inadvertently formed. Knowledge of the solubility envelope for the waste is necessary to avoid unwanted precipitation or gel formation in supernatants. Improvements in processing efficiency are expected if the retrieval, pipeline delivery and treatment plant processes are based on an understanding of the dissolution thermodynamics and kinetics rather than just empirical data. Water use and makeup chemical addition can also be reduced which, together with the improvement in efficiency, can reduce the amount of glass produced. Knowledge of waste solubility is necessary to avoid unwanted precipitation or gel formation in supernatants and to recover from such events should they occur. **Similar needs:** Need RL-WT090 deals with parallel issues for retrieval, delivery, and treatment of sludge-type wastes. **Program Baseline Summary (PBS) No.:** TW04 ** **Work Breakdown Structure (WBS) No.:** 5.02.02.01.02.01 ** **TIP No.:**
13	***Functional Performance Requirements*:** Solubility information for the major species expected in leach solutions shall be compiled in a form suitable for inclusion in the Environmental Simulation Program (ESP; a product of OLI Systems, Inc., Morris Plains, NJ), which is in use at the Hanford Site. The compilation shall include the major constituents, sodium and potassium salts of nitrate, nitrite, and hydroxide; important species aluminate, silicate, sulfate, carbonate, phosphate, fluoride, chloride, and chromium; and important

	radionuclides, including ^{60}Co, $^{89/90}Sr$, ^{99}Tc, ^{125}Sb, ^{137}Cs, ^{154}Eu, ^{155}Eu, ^{241}Am, ^{238}Pu, ^{239}Pu, and ^{240}Pu. The work shall include literature reviews to identify what solubility data are missing and identify what experimental work is needed to provide the missing data.
**	**Schedule Requirements:** Solubility information obtained in answer to this need will support the SST retrieval sequence analysis, which is updated annually throughout the life of the project, in accordance with Tri-Party Agreement Interim Milestones M-45-02D through M-45-02I .
14	***Definition of Solution*:**
15 *	***Targeted Focus Area*:** Tanks Focus Area (TFA)
16	***Potential Benefits*:** The main benefit of these activities will be to improve the reliability to retrieve, stage, and transfer low-activity waste feeds. Without this information, production expectations may not be met because of unexpectedly low waste solubility. An additional benefit is to improve planning for actions to recover from operational upsets. Better knowledge of plugging potential and of operational conditions that avoid plugging may permit loosening of overly restrictive process control requirements. This would reduce waste volume and programmatic time and costs.
17 *	***Potential Cost Savings*:**
18 *	***Potential Cost Savings Narrative*:**
**	***Technical Basis*:** This effort will provide a basis for feed delivery and treatment operations. The current state of knowledge is insufficient to predict, in all cases, what waste compositions and operating conditions will produce solids, and, if those solids form, whether they will be of such a nature as to result in pipe plugging.
19	***Cultural/Stakeholder Basis*:** Long-term disposal of the high-level wastes stored in Hanford's underground tanks is a national priority. The DOE has a legal agreement (the Tri-Party Agreement) with the Environmental Protection Agency and the State of Washington Department of Ecology to dispose of the waste according to a stated schedule. Adherence to this agreement is monitored by Native American tribal interests and a number of public interest groups. Program delays due to inability to retrieve and deliver waste feeds containing solids may violate the Tri-Party Agreement.
20	***Environment, Safety, and Health Basis*:** Completion of this work will make retrieval and delivery predictions more reliable, improving the reliability of the delivery sequence. These program improvements will decrease the possibility of programmatic delays, so that waste can be moved to safe storage as soon as possible.
21	***Regulatory Drivers*:** Tri-Party Agreement. This need supports the regulatory requirements for storage and transfer of waste.
22 *	***Milestones*:** Supports technical basis of TPA milestone M-45-02 "Submit annual updates to SST retrieval sequence document," 9/30/2000 and annually thereafter.
23 *	***Material Streams*:** Hanford high-level defense waste. Sludge, salt, liquid (RL-HLW-20)
24	***TSD System*:** Double Shell Tank Systems and Single Shell Tank Systems
25	***Major Contaminants*:** Fission products, actinides, nitrate. Pu-238, 239, 240, 241; AM-241; U-238; C-14; Ni-59/63; Nb-94; Tc-99; I-129;Cm-242; Sr-90; Cs-137; Sn-126; Se-79; chromium; nitrate; nitrite; complexants (EDTA/HEDTA)
26	***Contaminated Media*:** N/A. This project addresses wastes in engineered containment.
27	***Volume/Size of Contaminated Media*:** 204,400 m^3. See R. A. Kirkbride, "Tank Farm Contractor Operation and Utilization Plan," HNF-SD-WM-SP-012, Rev. 2, p. "Summary-3," (CH2M HILL Hanford Group, Inc., Richland, WA, April 19, 2000). For details, see, e.g., B. M. Hanlon, "Waste Tank Summary Report for Month Ending June 30, 2000," HNF-EP-0182-147, (CH2M HILL Hanford Group, Inc., Richland, WA, August 2000).
28 *	***Earliest Date Required*:** January 2001

29 *	***Latest Date Required*:** FY 2020
Baseline Technology Information	
30	***Baseline Technology/Process*:** A thermodynamic model known as the Environmental Simulation Program (ESP) is used in conjunction with the process tests. The ESP has been only partially validated with actual waste solubility data. **Technology Insertion Point(s):** N/A
31	***Life-Cycle Cost Using Baseline*:** Activities 150.B22, "Maintain the Operations & Utilization Plan," and 120.025, “Maintain WFD Technical Basis,” will make use of the data provided under this site need. Funds allocated for these activities are $3.1M in FY01 and $2.8M in FY02. Several activities provide funding for limited laboratory characterization of sludge wastes. Activities 120.V10 and 120.L10 provide $390K in FY01, and activities 120.R10 and 120.T10 provide the same amount in FY02. Life Cycle Costs related to Salt retrieval and transfer to the treatment plant are estimated at $10-20 Billion. This includes equipment, operations, maintenance and infrastructure upgrades over time, but does not include “closure”.
32	***Uncertainty on Baseline Life-Cycle Cost*:** Unknown
33	***Completion Date Using Baseline:*** Activities, "Maintain the Operations & Utilization Plan," and “Maintain WFD Technical Basis,” are planned to continue throughout the life of the project. The RPP is scheduled to complete post 2020.
Points of Contact (POC)	
34	***Contractor End User POCs*:** D.A. (Dan) Reynolds, CHG, 509-373-3115, F/509-373-4641 Daniel_A_Reynolds@rl.gov
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36 **	***Other Contacts:*** A. F. (Anne-Marie) Choho, CHG, 509-372-8280, F/509-373-6382, Anne-Marie_F_Choho@rl.gov K.A. (Ken) Gasper, CHG, 509-373-1948, F/509-376-1788, Kenneth_A_Ken_Gasper@rl.gov

*Element of a Site Need Statement appearing in IPABS-IS
**Element of a Site Need Statement required by CHG.